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AISI'S COLD-FORMED STEEL DESIGN SPECIFICATION - RECENT CHANGES

by

Albert L. Johnson (1)

INTRODUCTION

The newly published Edition of AISI's Specification for the Design of Cold-Formed Steel Structural Members represents a major revision, with many changes made to keep the Specification responsive to the needs of users. It reflects the results of research projects and improvements in design techniques.

This paper will highlight the more significant changes since publication of the 1968 Edition of the Specification, including those changes made in Addenda Numbers 1 and 2 published in 1970 and 1977. A description of the change, the reason for making the change with supporting evidence and its significance will be given. There is also an attempt to identify potential future changes to be based on research in progress and to continue to meet the changing needs of the design provision.

A number of editorial clarifications have been made throughout the Specification to lesson ambiguity and to make provisions less subject to misinterpretation. Equations have been numbered for the convenience of the user.

MAJOR CHANGES

The more significant revisions which appear in the latest Edition of the Specification can be grouped as follows:

Materials

Webs of Flexural Members

Inelastic Reserve Capacity of Flexural Members

Arc Welds

Bolted Connections

Wall Studs

Channel and Z-Sections Used As Beams

Tests For Special Cases

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MATERIALS

Occasionally there are reasons for using steels which are not listed by ASTM designation. In these cases, one of the most important factors is the ductility. The Specification now defines minimum ductility requirements as a minimum ratio of tensile to yield point and as a minimum elongation, as determined by a Cornell University study.

Steels with less ductility, such as full-hard ASTM A446 and A611, may be used provided the allowable basic design stress does not exceed 45 percent of the specified minimum yield nor 36 ksi. This removes a loop hole wherein there was no specific guidance for full-hard steels and where individual designers and manufacturers used different allowables.

The list of ASTM Specifications has been updated and expanded. The full-hard steels have been deleted from the basic list in keeping with the ductility provisions and new allowables. ASTM A446 Grade F has been added. High strength, low alloy hot rolled steel with improved formability has been added with listing of ASTM A715, Grades 50 and 60.

The thickness maximum of the Specification was increased to one inch in Addendum Number 2. This increase called for a listing of plate and bar steels to go above the thickness range covered by sheet and strip.

Delivered minimum thickness was spelled out in Addendum Number 2. This simply requires that the uncoated minimum thickness of the formed product as delivered be greater than or equal to 95 percent of the design thickness. This will avoid the possibility of capacity significantly less than required, and is particularly important in small thicknesses where rolling tolerances are greater.

WEBS FOR FLEXURAL MEMBERS

All the provisions which are concerned with web design have been extensively revised.

The maximum depth to thickness ratio of unreinforced webs has been increased to 200. For webs provided with transverse stiffeners, the depth to thickness ratio may be even greater: 260 when bearing stiffeners only are added, and 300 when both bearing stiffeners and intermediate stiffeners are added. Specific provisions for proportioning stiffeners are included.

Provisions for allowable shear and bending stresses in webs or beams have been changed in keeping with the increased maximum depth to thickness ratios. The shear allowables recognize the possible use of transverse stiffeners; the allowable bending stress differentiates between beams with stiffened compression flanges and beams with unstiffened compression flanges. An additional bending-shear interaction equation has been added for webs with transverse stiffeners.

Web crippling provisions have been modified and expanded. A tabular format is used to avoid confusion, with one table giving allowable concentrated loads for shapes with single webs, and another for sections which have a high degree of restraint against rotation of the web. Allowable

concentrated loads now depend on the inclination of the web and whether or not there are opposite concentrated loads, as well as the formerly used parameters of thickness, web depth, length of bearing, and bend radius.

Addendum Number 2 contained a reduction factor intended to avoid potential failure through the combined action of bending and web crippling. This factor was found to be excessively conservative, particularly when used in conjunction with the former allowables for bending moment and concentrated loads. Testing has indicated that a more liberal approach may be taken. In addition, there is an exception for certain cases of continuous beams at interior supports under specified conditions of lateral support and web spacing.

All of the changes on web limits, allowable stresses, and interaction are based on an extensive research project at the University of Missouri-Rolla. We may anticipate further refinement in the case of interaction of bending and crippling as additional tests sponsored by the Steel Deck Institute, AISI, and H. H. Robertson are completed and evaluated.

INELASTIC RESERVE CAPACITY OF FLEXURAL MEMBERS

A completely new section has been added to permit the designer to utilize a portion of the inelastic reserve under fairly tight restrictions. The member may not be subject to buckling, cold-forming may not be considered, and the member must be relatively compact. However, in those cases which qualify, the design moment may be as much as 75 percent of the yield moment or 60 percent of the ultimate moment. This new section is based on research at Cornell University.

ARC WELDS

The provisions for arc welds have been completely revised, based on a coordinated effort by AISI and American Welding Society. AWS D1.3, Specification for Welding Sheet Steel in Structures, is referred to for welding procedures, qualification, and inspection. Allowable stresses on welds made in accordance with the AWS Specification are given by AISI. These provisions apply for steel with connected parts 0.18 inches and less in thickness, with reference made to AISC for larger thicknesses. Of particular importance are design provisions for determining the carrying capacity of arc spot welds ("puddle welds"), and arc seam welds.

The coordinated AISI/AWS work involved cooperation among structural engineers and welding specialists. All of the welds now listed in the Specification were made under varying conditions, and their load carrying capacities evaluated by tests.

We do anticipate that further study will permit reduction or elimination of the pre-heat requirements for attaching deck to rolled structural shapes. Tension on arc spot welds is the next priority for future study; the Specification is silent on that loading mode at present.

BOLTED CONNECTIONS

Provisions for design of bolted connections have been completely revised, based on research at the University of Missouri-Rolla. All allowables are now based on ultimate strength rather than yield point. Criteria for bolted connections without washers have been added. The allowable shear stress on bolts has been increased, and small diameter high strength bolts are now covered with listing of ASTM A354 and A449.

The AISI provisions are for connections in which the thickness of the thinnest connected part is less than 3/16 inch. For greater thicknesses, reference is made to the AISI Specification.

Research in progress may provide additional information on bolt installation procedures. Because of the short grip length encountered in cold-formed construction, and the fact that friction joints are not permitted, the installation procedures used in heavier steel connections are not applicable.

WALL STUDS

Provisions for the design of wall studs which are braced by sheathing have been completely revised and expanded. The design is now based on the shear stiffness of the sheathing material, rather than on the extensional stiffness formerly used. The sheathing need not be identical on both sides of the stud; in fact, the provisions anticipate the possible use of sheathing on one side only. These revisions are based on research at Cornell University, and make reference to a computer program developed in conjunction with that research. Wall board parameters are given for common types of sheathing material, with reference to small specimen test procedures for determination of the parameters for other types of sheathing.

CHANNEL AND Z-SECTIONS USED AS BEAMS

For many years, the designer has been cautioned that "bracing may or may not be required" when only one flange is connected to deck or sheathing. More direct guidance to the designer has been given as a result of several areas of cooperative effort by the Metal Building Manufacturers Association and AISI. Tests continue, and there is some possibility that even more specific guidance to the designer can be provided in the future; however, we have made a significant improvement over previous editions.

The requirements for spacing of braces had been modified to relax the requirement of braces at the quarter points for the case when all loads and reactions on a beam are made through members which frame into the beam and thus act as braces. This case is encountered in the end walls of pre-engineered buildings.

TESTS FOR SPECIAL CASES

This entire section has been arranged to improve clarity. Substantive changes include a clear distinction between performance tests and confirmatory tests. In the case of performance tests, the multipliers for dead and live

load now include a higher multiplier for capacity limited by connection failure, reflecting the higher margin between service load and ultimate load for connections. The provisions for compression yield point determinations, used in determining the influence of cold work, anticipate publication of a stub column test procedure in the near future.

OTHER CHANGES

A few other substantive changes warrant attention.

A new section has been added for the case of torsional buckling of point symmetric sections, such as cruciform sections. This is a rare occurrence, but it was believed appropriate to provide specific recommendations.

The section on bracing and secondary members has been deleted. This section permitted a higher compression stress on the gross section of axial loaded bracing and secondary members; it was deleted because of the lack of an accepted definition for that type of member.

ANTICIPATED FUTURE REVISIONS

Several areas where further changes are anticipated were noted in the foregoing discussion. Other portions of the Specification where we may expect changes in the future are in the treatment of flange stiffeners, the design approach for unstiffened compression elements, and column design. Research in these areas is complete or is nearing completion, and proposed revisions will be drafted for consideration by the Advisory Group on the Specification.

ACKNOWLEDGEMENTS

AISI acknowledges the devoted efforts of the members of the Advisory Group on the Specification for the Design of Cold-Formed Steel Structural Members. This group, comprised of consulting engineers, researchers, designers from companies manufacturing cold-formed steel members, components, assemblies, and complete structures, and specialists from the steel producing industry has met two to three times per year since its establishment in 1973. Its members have made extensive contributions of time and effort in developing and reaching consensus on the changes which have been described above.

All users of the Specification are invited to continue to offer their valuable comments and suggestions. The cooperation of all involved, the users as well as the writers, is needed to continue to keep the Specification up to date and a useful tool for the designer.

